

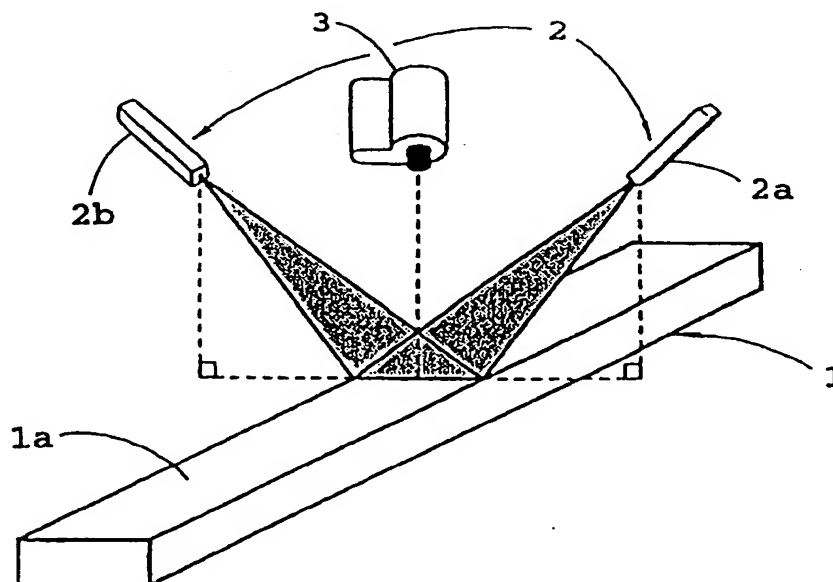


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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/SE95/00212 <b>(22) International Filing Date:</b> 1 March 1995 (01.03.95) <b>(30) Priority Data:</b> 9400849-7      8 March 1994 (08.03.94)      SE <b>(71) Applicant (for all designated States except US):</b> SOLITON ELEKTRONIK AB [SE/SE]; Teknikringen 1A, S-583 30 Linköping (SE). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> ÅSTRÖM, Anders [SE/SE]; Stenbrötsgatan 41, S-582 47 Linköping (SE). ÅSTRAND, Erik [SE/SE]; Bygdegatan 305, S-583 31 Linköping (SE). <b>(74) Agents:</b> WILLQUIST, Bo et al.; Albihn Willquist AB, S:t Larsgatan 23, S-582 24 Linköping (SE).		<b>(81) Designated States:</b> AU, CA, NZ, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Swedish).</i>

**(54) Title:** ARRANGEMENT AND METHOD FOR THE DETECTION OF DEFECTS IN TIMBER**(57) Abstract**

The present invention relates to an arrangement and a method for the detection of defects in timber. The arrangement comprises at least one linear light source (2) for illuminating a wood surface (1a) capable of moving relative to the light source (2) and a light sensor (3) arranged above the aforementioned wood surface. The field of vision of the sensor (3) covers an area next to an illuminated line of light, and the sensor (3) is so arranged as to detect the presence of scattered light in the wood in that area. The sensor (3) is linked to image processing and signal processing circuits, which are so arranged as to identify defects in the timber on the basis of the light scatter detected in the wood. The invention also relates to a method in which the arrangement in accordance with the foregoing is utilized.

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Arrangement and method for the detection of defects in timber

The present invention relates to an arrangement for the detection of defects in timber comprising at least one linear light source for illuminating a wood surface capable of moving relative to the light source and a light sensor  
5 arranged above the aforementioned wood surface.

The invention also relates to a method for the detection of defects in timber, in which a timber object is illuminated by at least one linear light source and an image is detected by  
10 a sensor arranged above the timber object.

Within the sawmill and joinery industry, for example, the identification of defective timber in an effective fashion, after sawing and also before further processing in a second  
15 stage, has long been a major problem; sorting is still a partially manual operation in many places. The criteria for what constitutes defects can vary in many cases depending on the area of application of the timber, which makes it important to be able to identify the type of defects present  
20 in a piece of timber.

Systems are certainly now available for the automatic identification of timber with certain defects, although these systems have a limited capacity to detect defects. Previously  
25 disclosed systems are able at the present time to detect darker cracks, resin pockets, larger cracks and pith edges in timber, although they are unable to detect light knots and cracks satisfactorily. The previously disclosed systems are also unable to distinguish between a resin pocket or a pith  
30 edge that is detected.

The object of the present invention is to make available an arrangement for the detection of defects in wood, which, by means of a combination of linear light sources and a sensor,  
35 solves the above problem, and is at least capable of detecting knots, cracks, resin pockets and pith edges. The

invention is based on the so-called Tracheid effect, which means that light striking a wooden surface is scattered into the wood, and in so doing creates a light area around the point at which the incident light strikes the surface. The  
5 light is scattered differently depending on the direction of the wood fibres and depending on the presence of defects in the wood. Either by studying the intensity of the scattered light, or by comparing the scattered light with the directly reflected light, it is possible to determine whether a defect  
10 is present.

The object of the invention is met in that the field of vision of the sensor covers an area next to a line of light illuminated by each light source, in that the sensor is so  
15 arranged as to detect the presence of scattered light in the wood in that area, and in that the sensor is linked to image processing and signal processing circuits which are so arranged as to identify defects in the timber on the basis of the light scatter detected in the wood.

20 In order to reduce the required image processing, each light source is arranged in accordance with one particular feature of the invention essentially in the same plane as the sensor, the field of vision of which is arranged symmetrically about  
25 the illuminated line.

According to a further particular feature of the invention, the sensor is also so arranged as to detect reflected light from the aforementioned lines of light, and the image  
30 processing and signal processing circuits are so arranged as to identify defects in the timber on the basis of a combination of the detected light scatter and the light reflected from the lines of light.

35 In accordance with one preferred embodiment of the invention, the arrangement comprises two linear light sources, which are arranged to either side of the timber in the longitudinal sense of the timber and at such a distance in relation to one

another that they appear as separate lines when they are detected in the sensor, in conjunction with which the image processing and signal processing circuits are so arranged as to make comparisons between these two detected lines of light.

A second object of the invention is to make available a method for the detection of defects in timber, which permits the detection of a number of different defects. This object is achieved in that light scattered in the wood in an area around a line of light generated by each light source is detected in a sensor, and in that the detected light scatter is utilized in image processing and signal processing circuits for the purpose of identifying defects in the timber.

In accordance with one preferred characteristic of this method, the light scatter is detected in an area lying symmetrically about the illuminated line.

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In accordance with one particular characteristic of this method, reflected light is detected from the aforementioned line of light in the sensor, in conjunction with which both the detected light scatter and the light reflected from the line of light are utilized in the image processing and signal processing circuits for the purpose of identifying defects in the timber.

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The invention is described below in greater detail with reference to the accompanying drawings, in which Figures 1 and 3 illustrate different embodiments of the invention, and Figures 2 and 4 show the image that is projected onto the sensor surface for these embodiments.

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In the embodiment shown in Fig. 1, a long, sawn wooden object 1 is illuminated by two linear light sources 2a, 2b. The light sources 2a, 2b are arranged in the longitudinal sense of the object and are angled towards the wooden object in

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such a way as to provide uniform illumination of it. The light sources 2a, 2b are also arranged at a certain distance from one another and in the same plane as a sensor 3 arranged vertically above the wooden object 1. This sensor 3 is  
5 arranged so that it lies directly above the point at which the beams from the two light sources meet. The wooden object 1 is fed preferably in the longitudinal direction, although it is naturally also possible to feed the wooden object in the transverse direction, or to cause the light sources and  
10 the sensor to move in relation to the piece of timber.

The sensor 3 has the ability to detect both the light scattered from the light sources in the wooden object 1 and the light reflected directly on the wooden object 1. The  
15 image perceived by the sensor can be appreciated from Fig. 2. In order to compensate for the fact that the intensity of the light differs considerably between the scatter image perceived by the sensor 3 and the reflection image, the sensor must, for the purpose of detecting the scatter image,  
20 collect light from a larger area than that used for detecting the reflection image. If a sensor of identical size is used for all the image elements, this can be achieved by adding together a number of image elements in a longitudinal sense on both sides of the direct line. Another alternative way of  
25 compensating for the lower light intensity is to make the exposure time longer for the image elements struck by the scattered light, than for the image elements struck by the direct light. A third alternative is to use one sensor for detecting the light reflected directly on the surface of the  
30 wood, and a second sensor for detecting the light scattered in the wood.

In the image of the timber that can be obtained by studying the intensity of the light scattered in the timber, the so-  
35 called Tracheid effect, it is possible readily to distinguish cracks, both light and dark knots, and pith edges. This can be performed, for example, by causing the image processing and signal processing circuits to detect objects of a

predetermined type in the received image. This can be performed in a simple fashion by comparing the light intensity at each point with a predetermined value. With the help of more advanced image analysis, high reliability of detection can be achieved, and the type of defect can even be classified.

In a preferred embodiment of the invention, the intensity of the directly reflected line of light can also be utilized to detect defects in the wood. In the image supplied by the sensor 3, which is obtained on the basis of the directly reflected light, it is possible to detect cracks, knots, pith edges and resin pockets using the arrangement in accordance with Fig. 1, on condition that the defects are not very light. It is nevertheless difficult to classify the various types of defect simply by using this grey-scale image as the starting point.

If, on the other hand, a combination of the image generated by the light scatter and the image generated by the direct reflection is used, it is possible by image analysis to determine the type of defects present in the timber. The image generated by the Tracheid effect essentially shows only knots and pith edges, which appear as very dark areas in the image supplied by the sensor. The light scatter associated with these types of defect differs from that in the surrounding wood, which makes it easy to identify the type of defect present in the timber. The information from this image can then be combined with the information in the ordinary image, so that it is possible with a good degree of accuracy to determine what types of defect are present in the timber.

In the arrangement illustrated in Fig. 3, the linear light sources 2a, 2b must be arranged in such a way in relation to one another that the lines of light formed lie adjacent to one another at a distance such that they appear as separate lines when they are detected in the sensor. By comparing the intensity of the light reflected on the wood surface by these

light sources, it is possible to detect both the presence of wane edges on the timber and surface irregularities.

By introducing a third linear light source 2c in accordance with the arrangement shown in Fig. 3, it is possible to obtain a three-dimensional profile of the timber. By comparing the intensity of the light sources arranged on the side of the timber with the intensity of this third light source, it is possible to detect any deviations in the direction of the fibre in the timber. When a less accurate analysis of the characteristics of the timber is required, it is also possible, of course, to utilize only the image generated by the direct reflection.

In a preferred embodiment of the present invention, use is made of a two-dimensional sensor which contains circuits for parallel image processing and signal processing, for example the so-called MAPP2200 sensor. This type of sensor is preferred, as it permits the detection and processing of both the directly reflected light in a line of light and the light scattered in the timber due to the Tracheid effect. The sensor offers, amongst other things, the opportunity to combine a number of image elements on each side of the line of light, and to make comparisons between the total intensity achieved and the intensity of the line of light. Other types of sensors are entirely possible, of course, and the invention is in no way dependent on the aforementioned sensor.



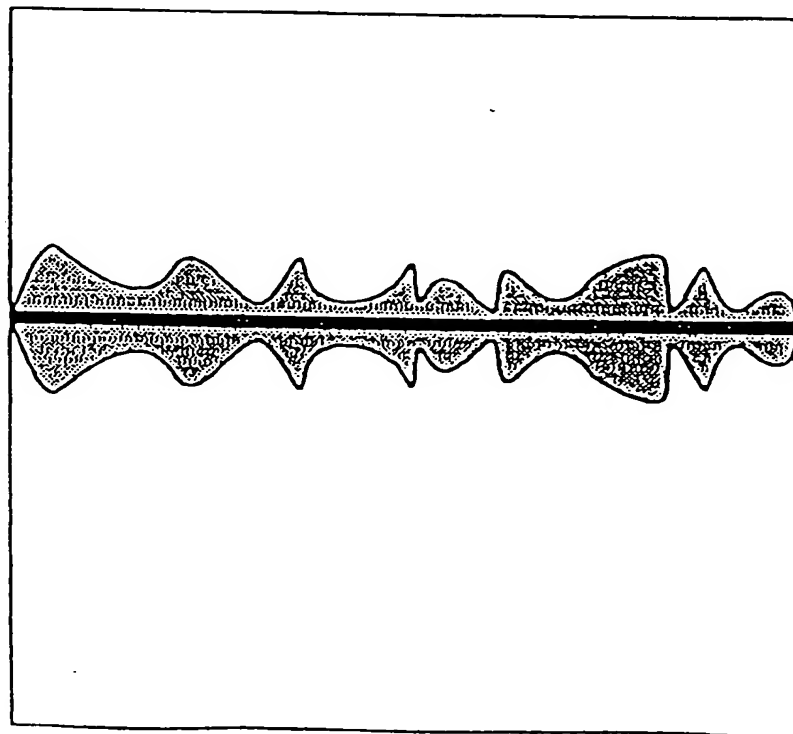
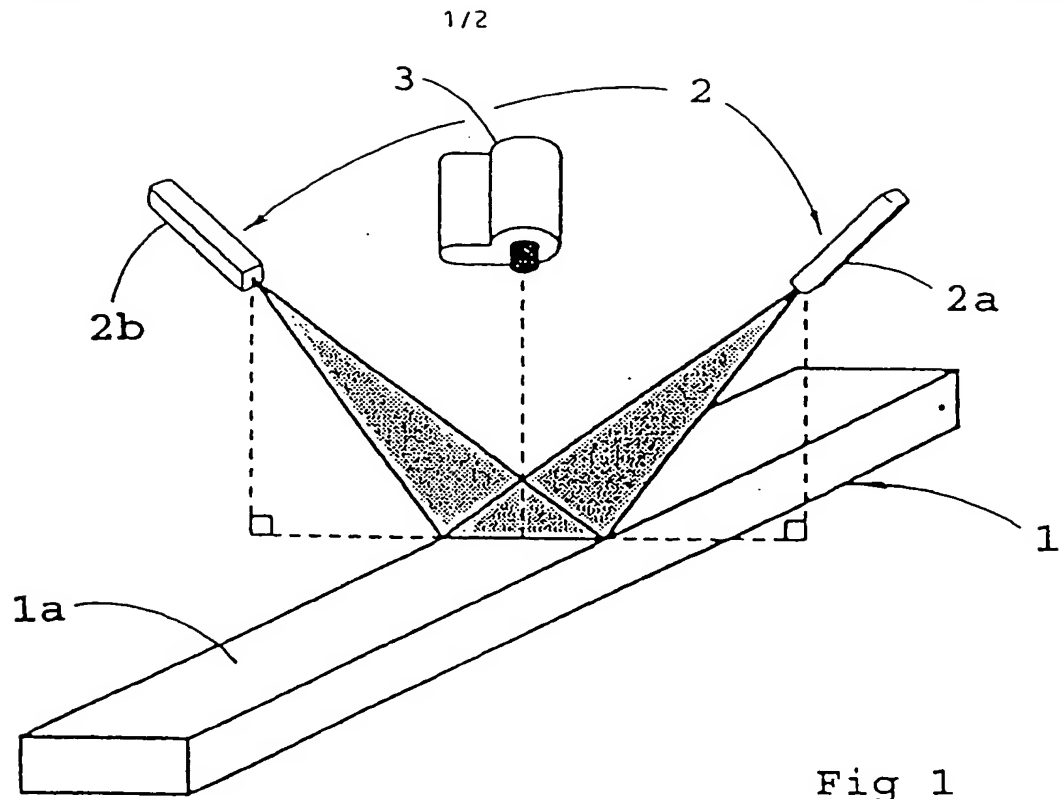
Patent Claims

1. Arrangement for the detection of defects in timber comprising at least one linear light source (2) for illuminating a wood surface (1a) capable of moving relative to the light source and a light sensor (3) arranged above the aforementioned wood surface (1a), *characterized* in that the field of vision of the sensor covers an area next to a line of light illuminated by each light source (2), in that the sensor (3) is so arranged as to detect the presence of scattered light in the wood in that area, and in that the sensor (3) is linked to image processing and signal processing circuits, which are so arranged as to identify defects in the timber on the basis of the light scatter detected in the wood.
2. Arrangement in accordance with Patent Claim 1, *characterized* in that each light source (2) is arranged essentially in the same plane as the sensor (3), the field of vision of which is arranged symmetrically about the line illuminated by each light source.
3. Arrangement in accordance with one or other of the preceding Patent Claims, *characterized* in that the sensor (3) is so arranged as to detect reflected light from the aforementioned lines of light, and in that the image processing and signal processing circuits are so arranged as to identify defects in the timber on the basis of a combination of the detected light scatter and the light reflected from the lines of light.
4. Arrangement in accordance with one or other of the preceding Patent Claims, *characterized* in that it comprises two linear light sources (2a, 2b), which are arranged to either side of the timber in the longitudinal sense of the timber and at such a distance in relation to one another that they appear as separate

lines when they are detected in the sensor (3), and in that the image processing and signal processing circuits are so arranged as to make comparisons between these two detected lines of light.

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5. Method for the detection of defects in timber, in which a timber object (1) is illuminated by at least one linear light source (2) and an image is detected by a sensor (3) arranged above the timber object (1),  
10 *characterized* in that light scattered in the wood in an area around a line of light generated by each light source is detected in a sensor (3), and in that the detected light scatter is utilized in image processing and signal processing circuits for the purpose of  
15 identifying defects in the timber.
6. Method in accordance with Patent Claim 5, *characterized* in that the light scatter is detected in an area lying  
20 symmetrically about the line illuminated by each light source.
7. Method in accordance with Patent Claims 5 or 6, *characterized* in that light reflected from the  
25 aforementioned line of light is detected in the sensor (3), and in that both the detected light scatter and the line of light are utilized in the image processing and signal processing circuits for the purpose of identifying defects in the timber.



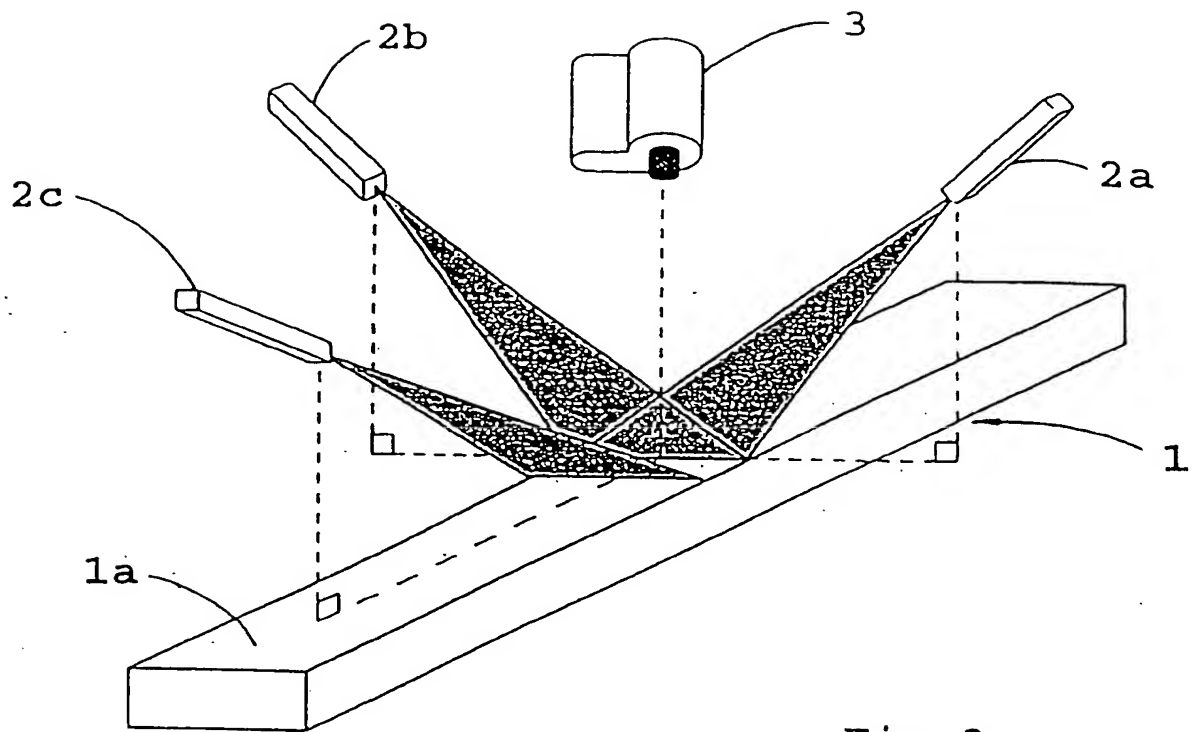


Fig 3

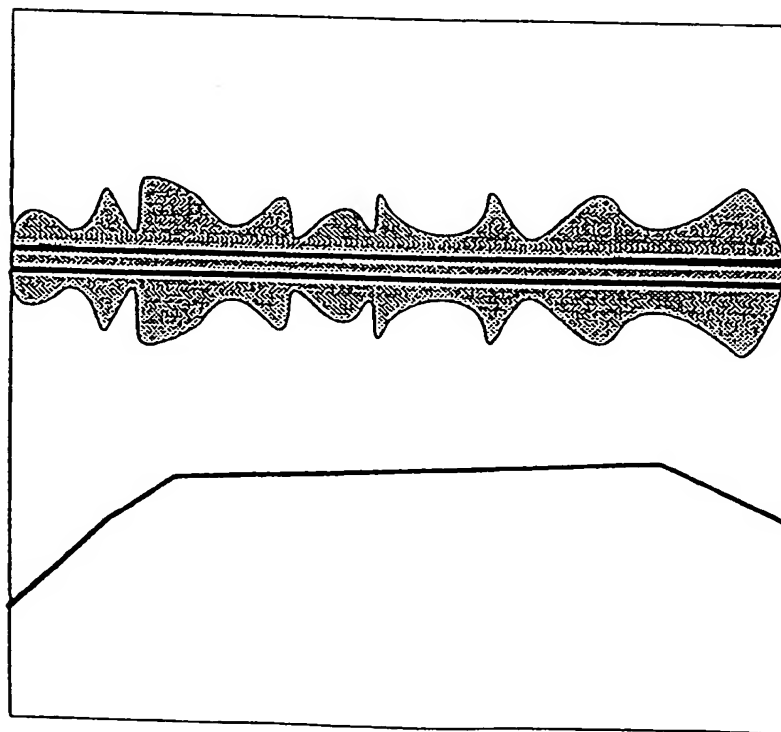


Fig 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00212

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01N 21/84, G01N 33/46, G01B 11/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01N, G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, A, 4104501 (REMA CONTROL AB), 5 Sept 1991 (05.09.91)  -----	1,5

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE-A-	4104501	05/09/91	SE-B,C-	464105	04/03/91
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